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An Experiment to Explore Persistence of Bullet Striations

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An Experiment to Explore Persistence of Bullet Striations

Disciplines

Forensic Science and Technology

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An Experiment to Explore Persistence of Bullet Striae

Heike Hofmann (hofmann@iastate.edu, @heike_hh)
Alicia Carriquiry
ISU CSAFE bullet team

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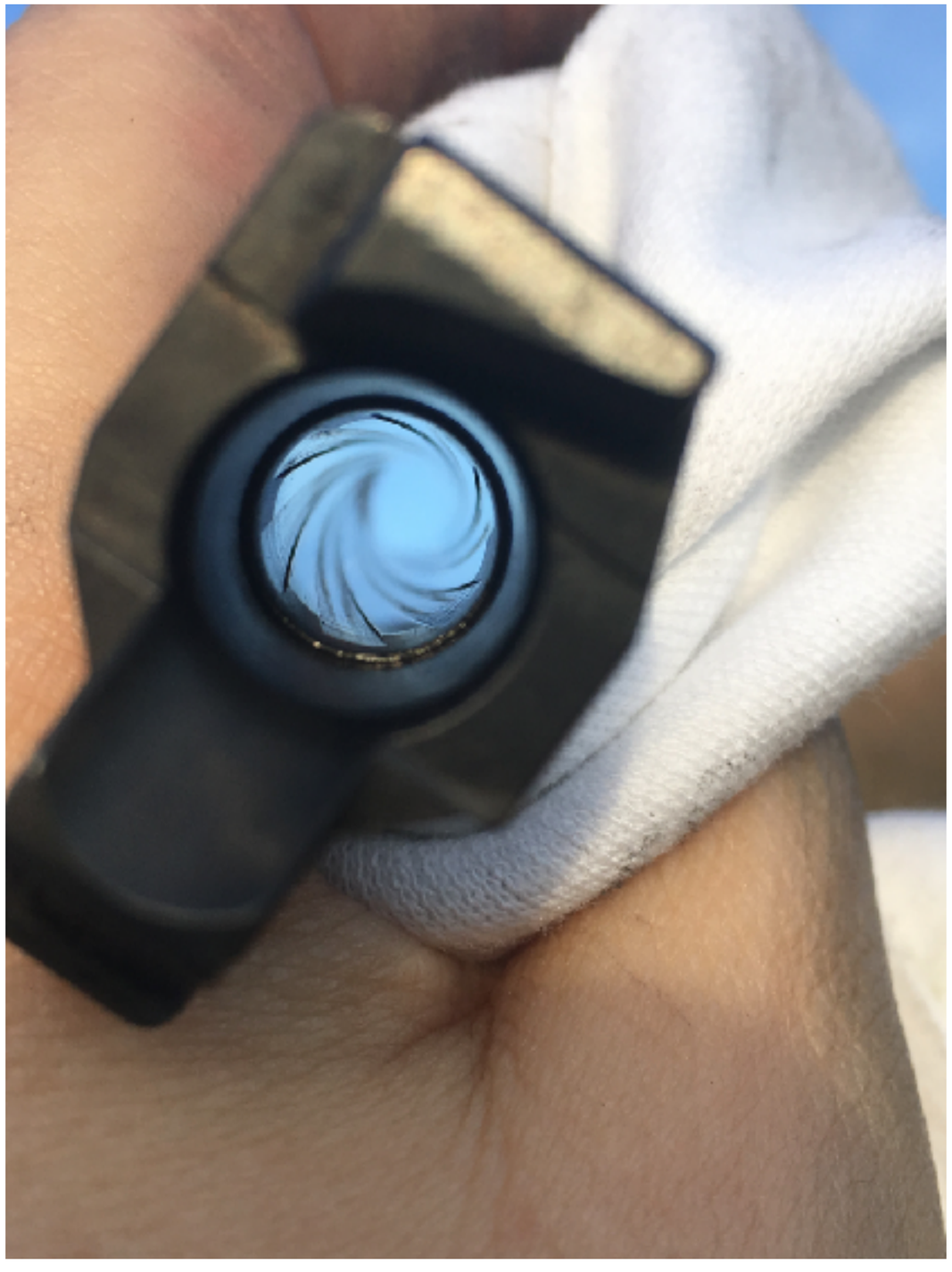
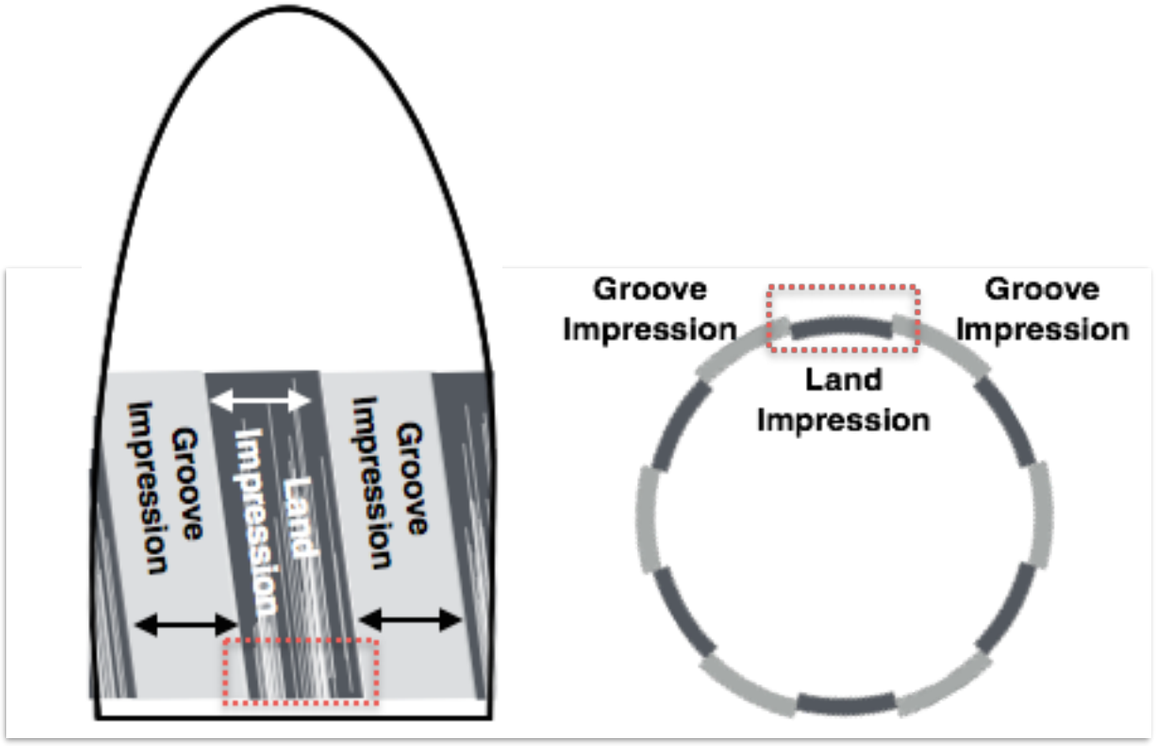
ForensicStats.org

Barrel rifling and striae



★ Barrel rifling introduces land and groove impressions on bullets

★ micro-imperfections introduce striation marks



How persistent are the marks?

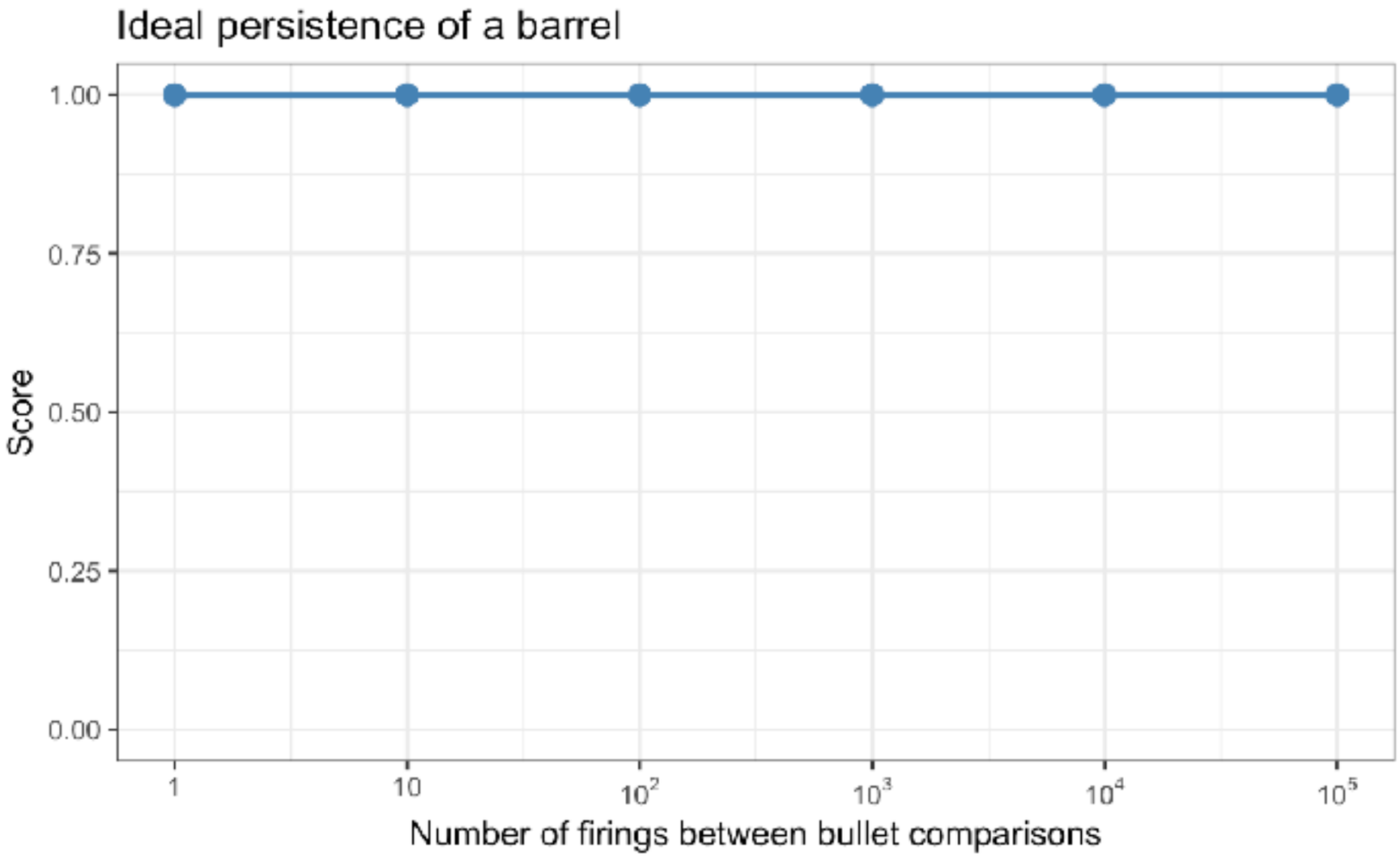
★ **“Unique as finger prints”**: striae are assumed to be unique to a barrel

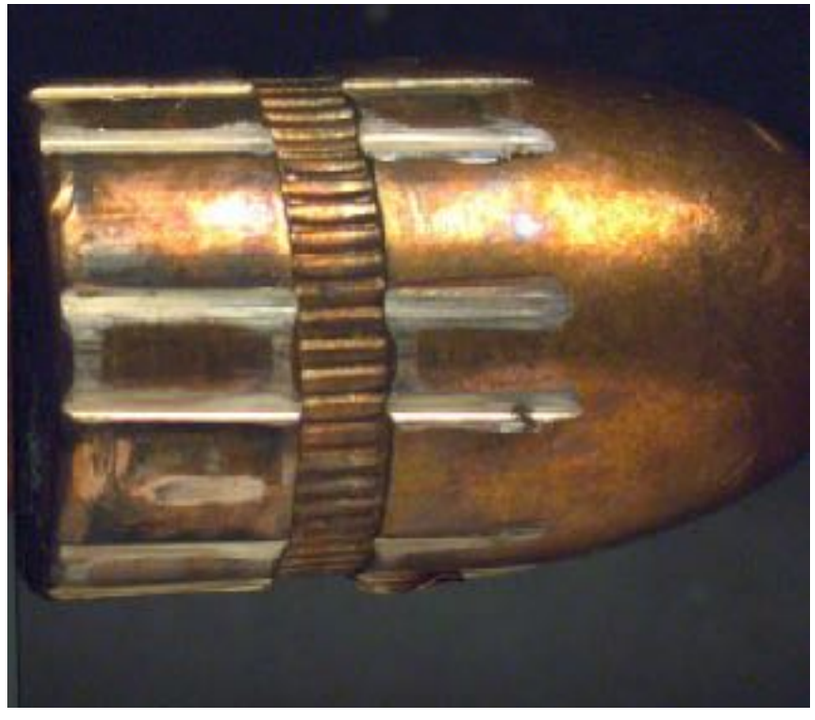
★ **How fluid are the markings?**

★ **Goal**: use *score* as objective measure for the match, keep track of it over number of firings

Ideally …

- ★ **Similarity Score** between 0 and 1
- ★ Higher scores indicate higher similarity between bullets





Ideally …

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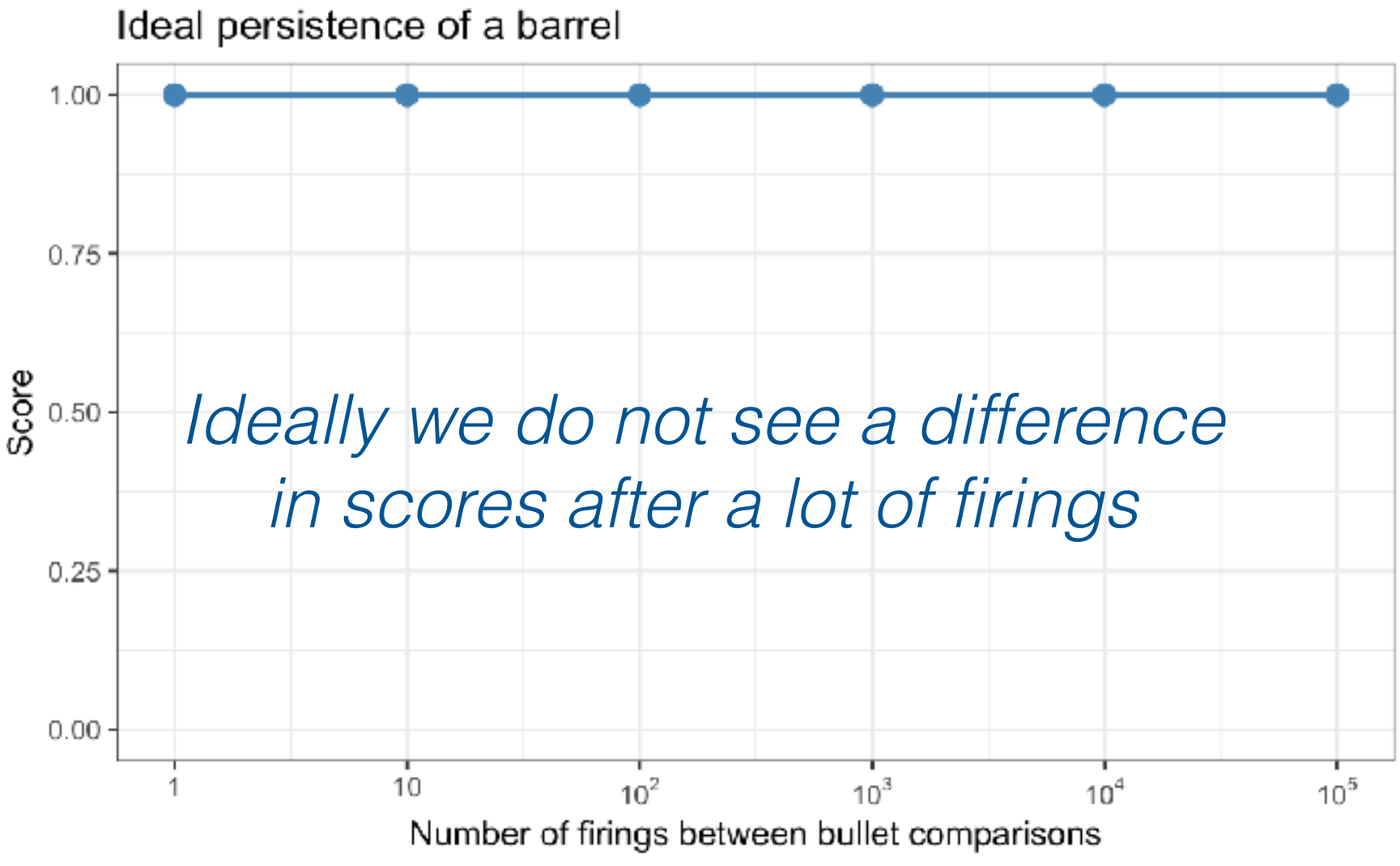

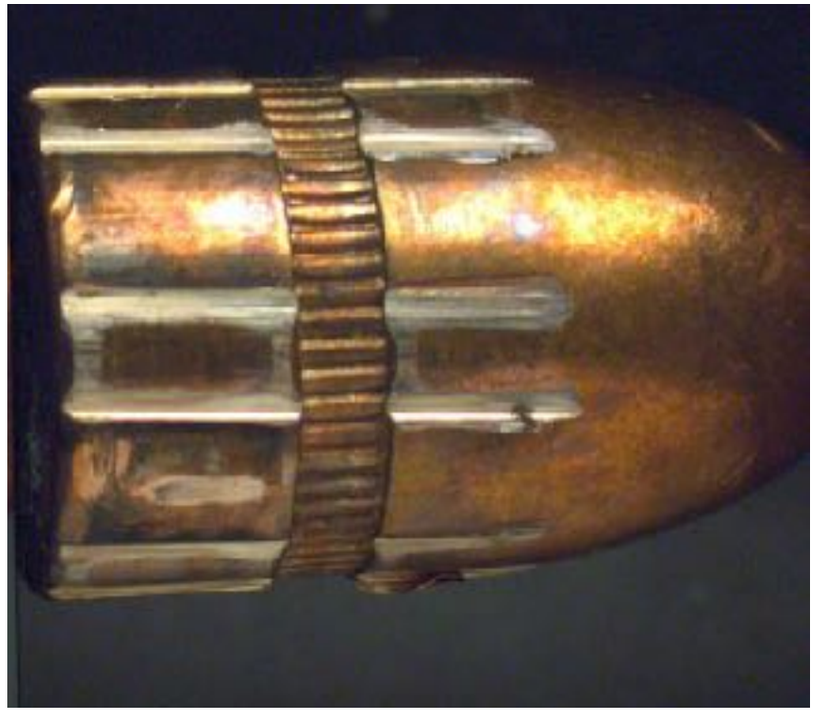

Existing studies

- **Steve Kramer, St Louis PD**
  - 2 barrels of Sig Sauers, 2 bullets every 25 shots up to 3500
- **Alan Xiaoyu Zheng, NIST, “Cary study”**
  - Ruger P89, shots 1-10, then every 25th up to 2000
- **Houston FSC**
  - multiple barrels
  - shots 11-50

Comparing bullets

★ **Cary Persistence**

~ $90^2/2$ = 4,005 pairwise comparisons

★ **Steve Kramer**

~ $280^2/2$ = 39,060 pairwise comparisons for each barrel

★ **Houston FSC**

~ $40^2/2$ = 780 pairwise comparisons for each barrel

automatic matching enables pairwise comparisons

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Microscope Facility

Roy J. Carver High Resolution Microscopy Facility

Two Sensofar Confocal Light Microscopes

Six undergraduates scanning bullet lands

3d topographic images: height measurements on x-y grid

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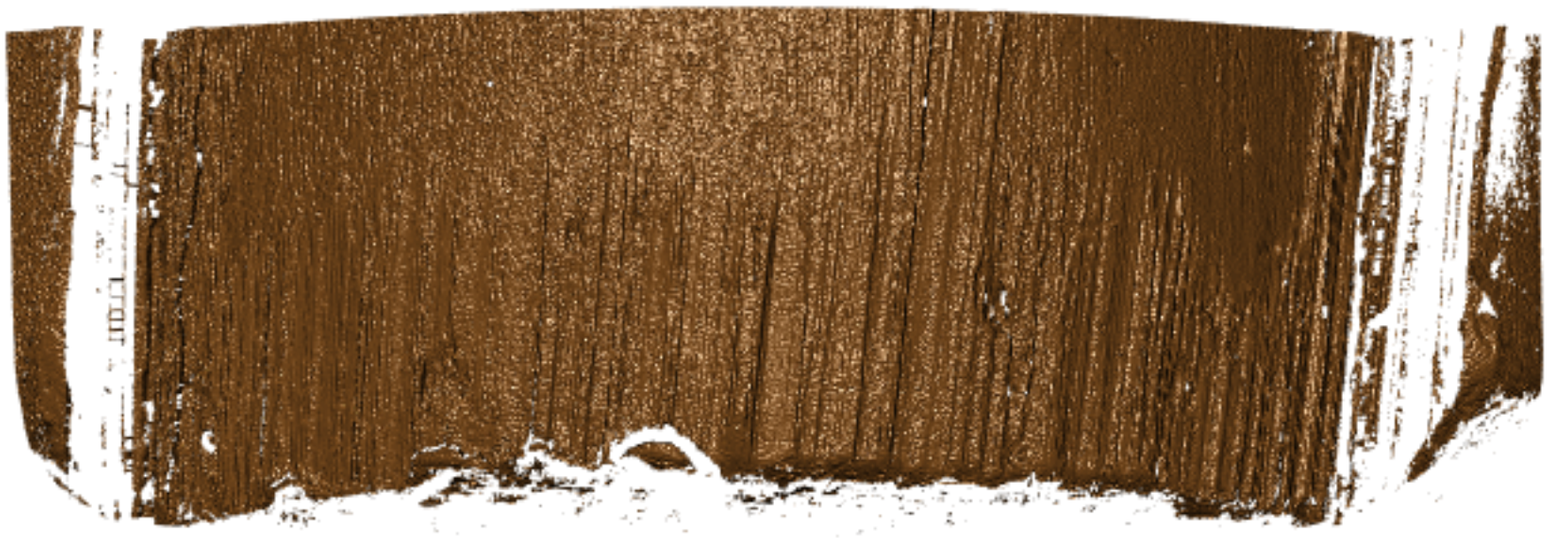
Cary Persistence

NIST Ballistics Research Database NBRD

- ★ bullets kept: shots 1-10, then every 25th up to 2000
- ★ same land on each bullet identified & scanned

bullet #1



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Cary Persistence

NIST Ballistics Research Database NBRD

★ bullets kept: shots 1-10, then every 25th up to 2000

★ same land on each bullet identified & scanned

bullet #2

bullet

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Cary Persistence

NIST Ballistics Research Database NBRD

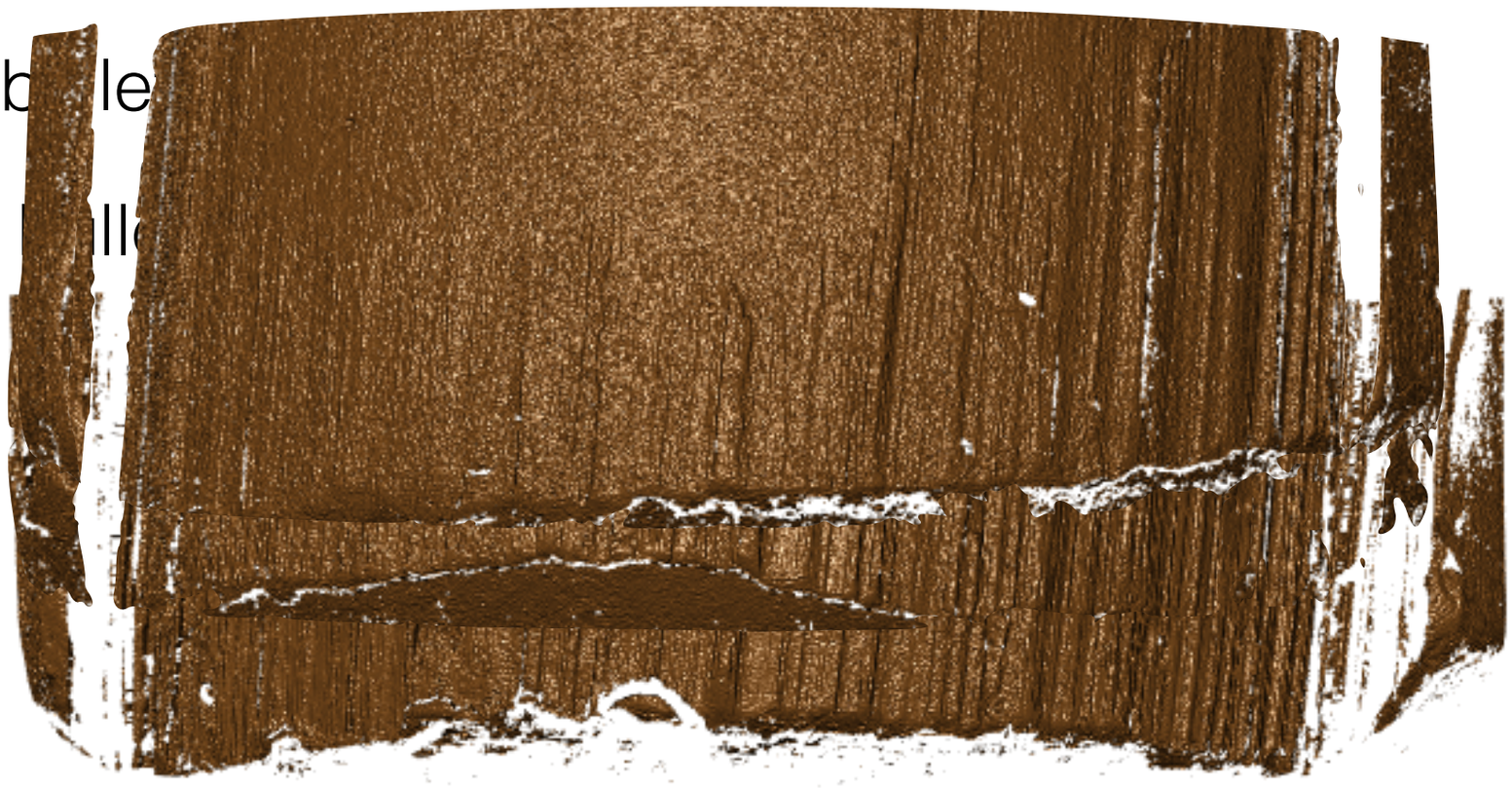
★ bullets kept: shots 1-10, then every 25th up to 2000

★ same land on each bullet identified & scanned

bullet #100

b le

ll



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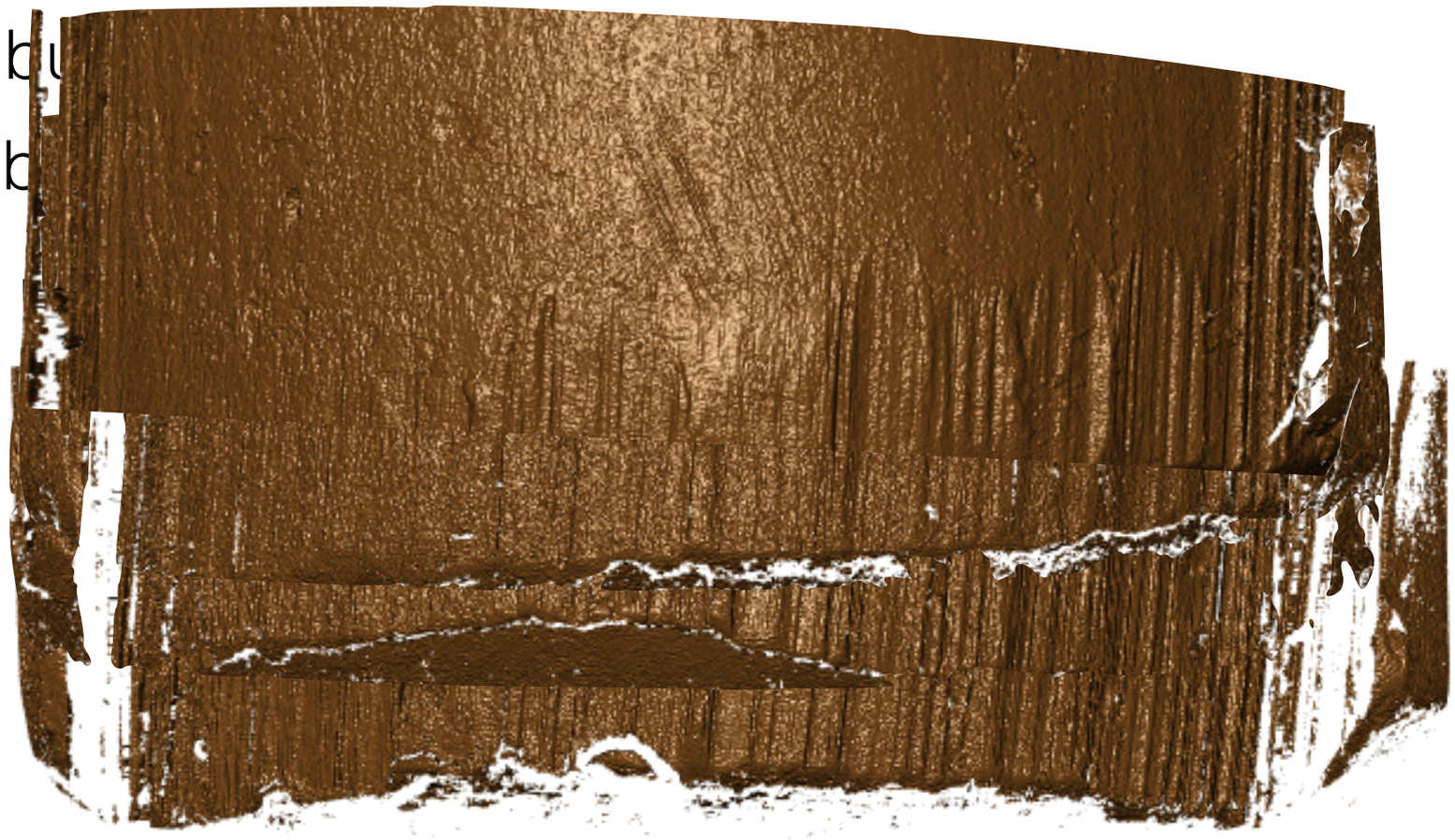
Cary Persistence

NIST Ballistics Research Database NBRD

★ bullets kept: shots 1-10, then every 25th up to 2000

★ same land on each bullet identified & scanned

bullet #2000



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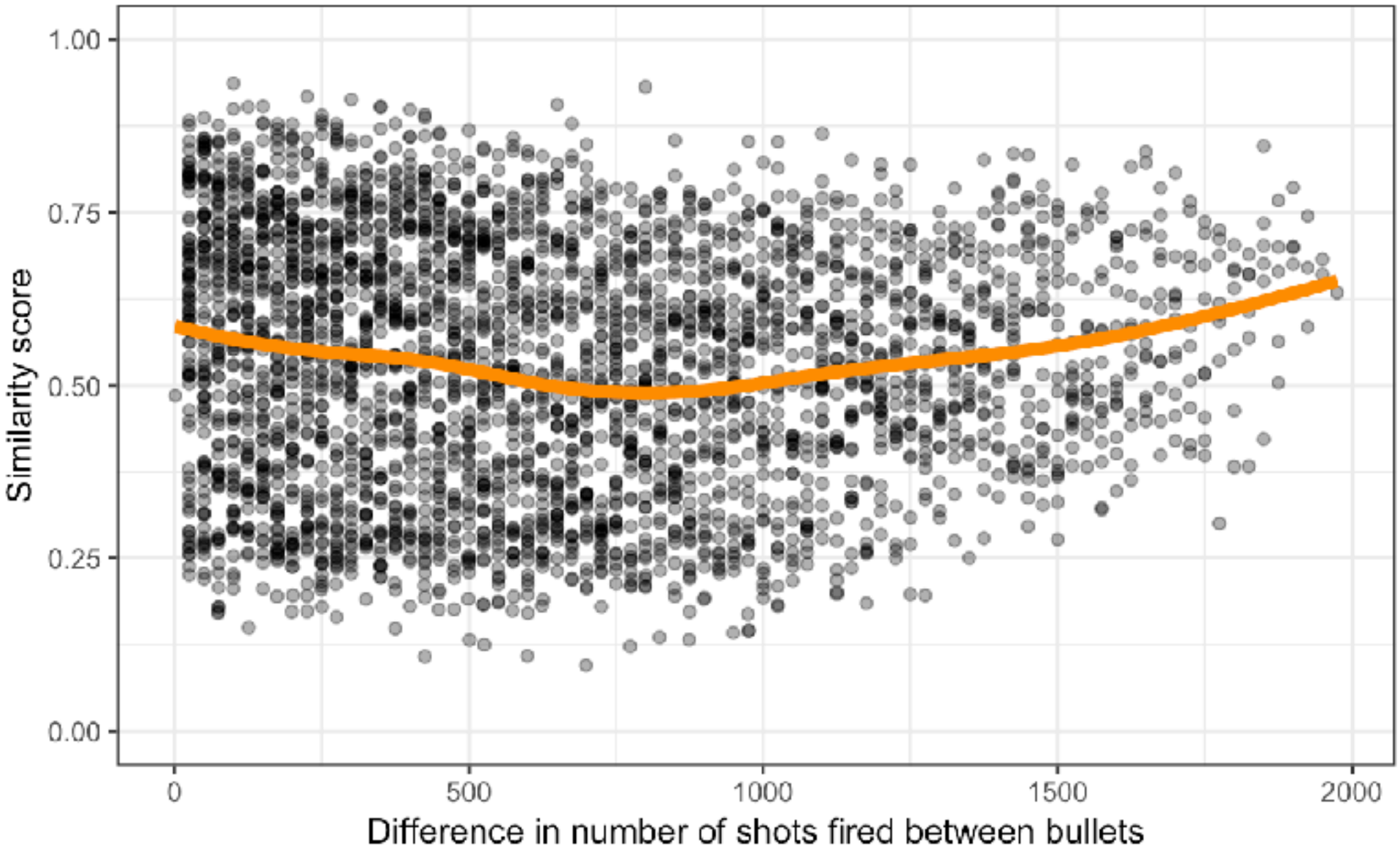
Cary Persistence

Pairwise comparisons of all 90 scans

★ All scans feature the same land



Automatic matching of bullet land impressions, Annals of Applied Statistics, Eric Riemer Hare, Heike Hofmann, and Alicia Carriquiry

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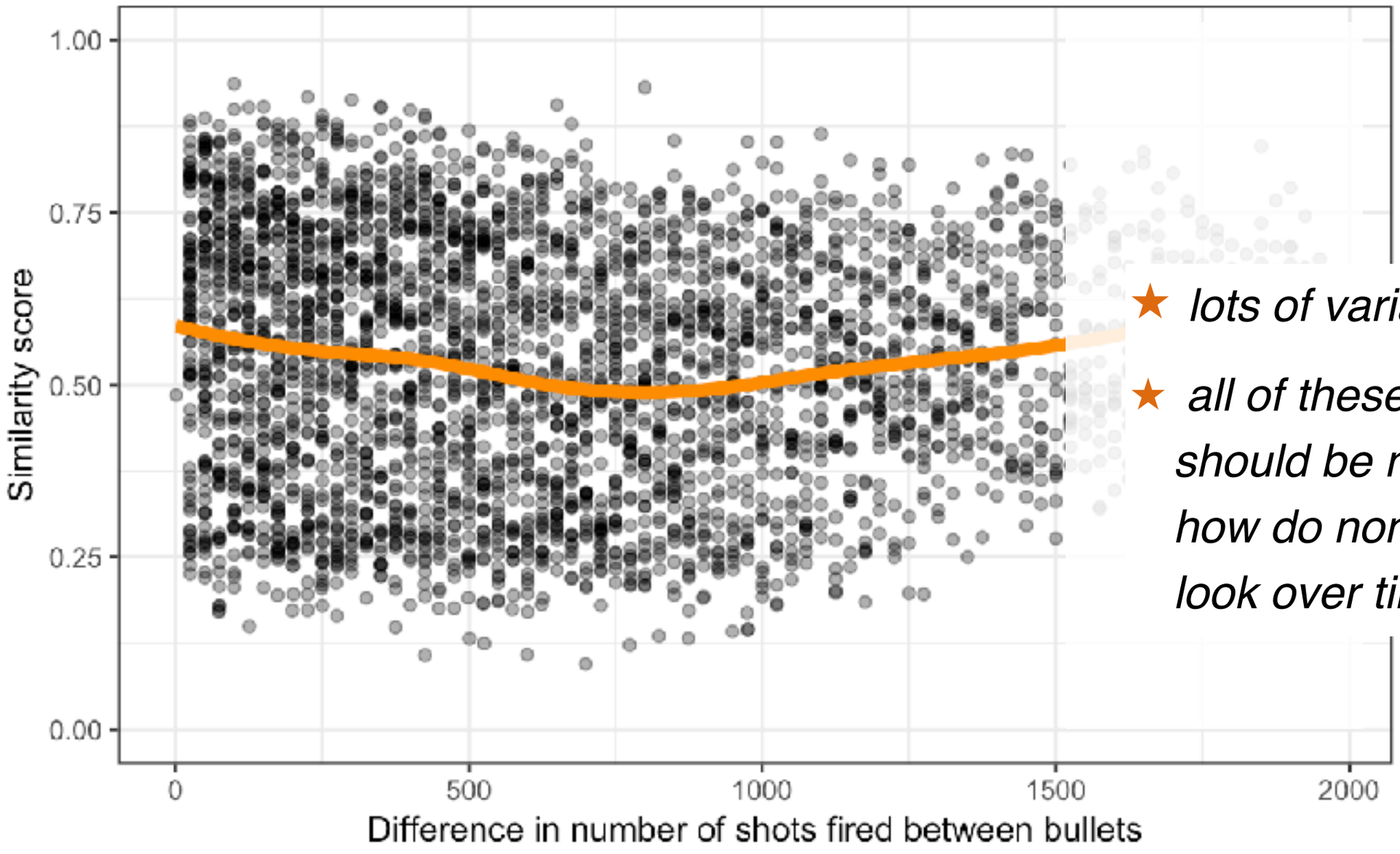

Automatic matching of bullet land impressions, Annals of Applied Statistics, Eric Riemer Hare, Heike Hofmann, and Alicia Carriquiry

★ *lots of variability!*

★ *all of these scores should be matches - how do non matches look over time?*

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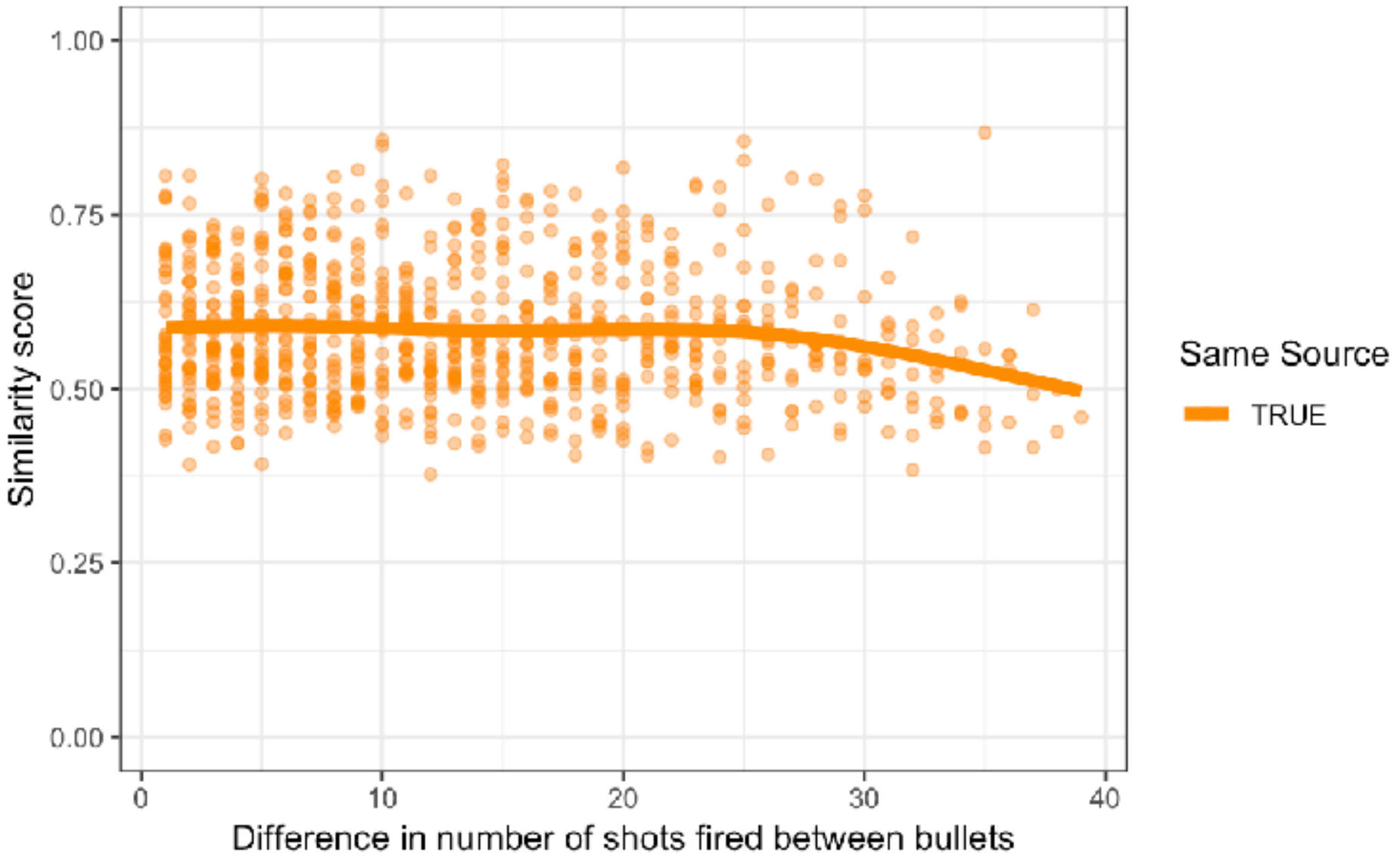
Houston FSC

Pairwise comparisons of bullets 11-50

★ Pairwise comparisons for bullets 11-50 from one barrel



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Houston FSC

Pairwise comparisons of bullets 11-50

★ Pairwise comparisons for bullets 11-50 from one barrel

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Houston FSC

Pairwise comparisons of bullets 11-50

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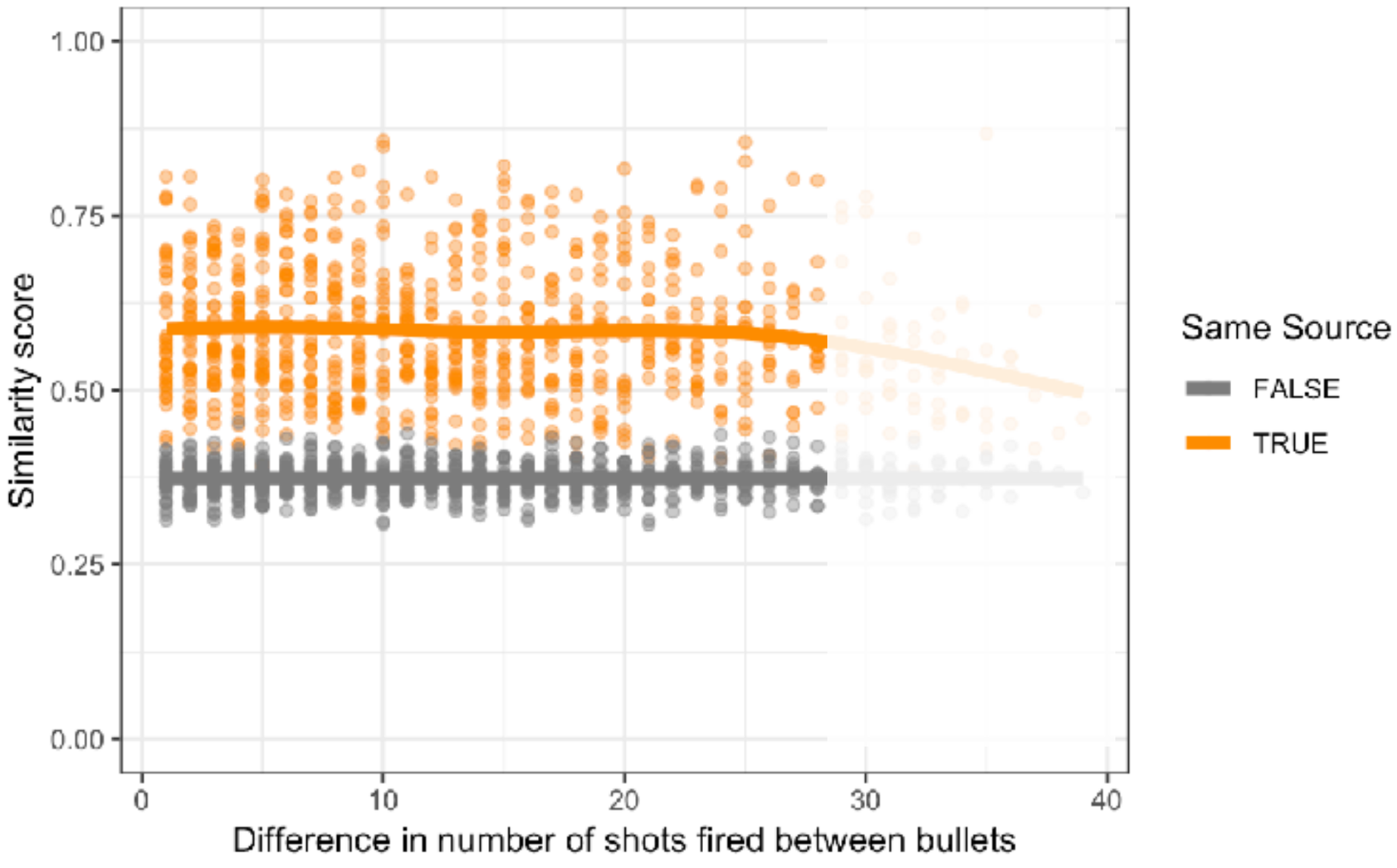

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Houston FSC

Pairwise comparisons of bullets 11-50

★ Pairwise comparisons for bullets 11-50 from one barrel

★ *still a lot of variability!*

★ *same source scores are fairly well separated from different source scores*

★ *scores remain fairly flat over time*

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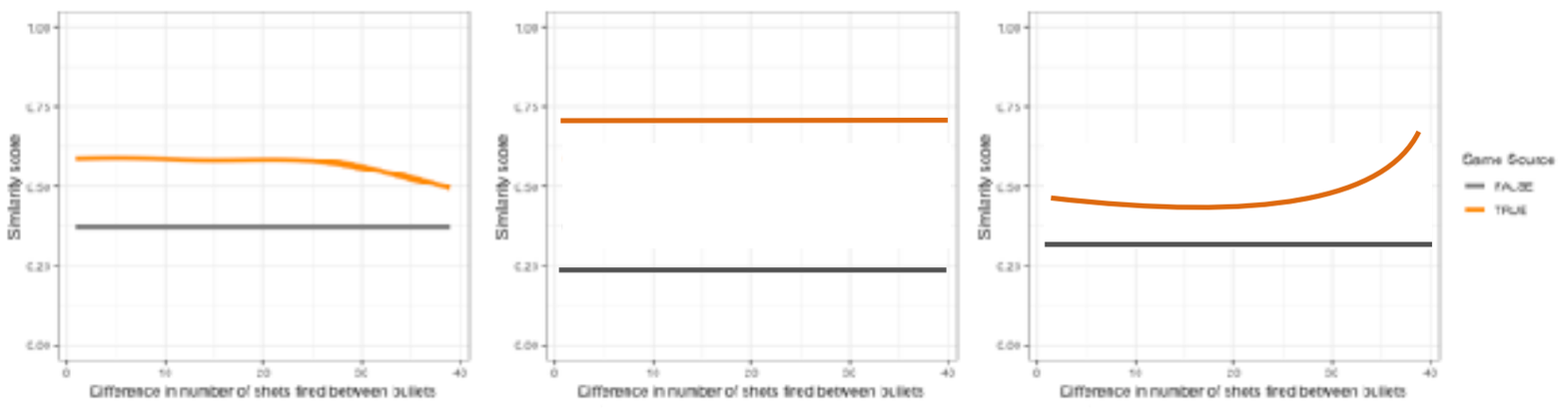
Question of Persistence



★ automatic matching forms basis to tackle question of persistence

★ persistence is affected by model/make, barrel and probably ammunition

★ we need a database to fill in missing pieces

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CSAFE Persistence

- ★ Collaboration with Story County Sheriff's Office and DCI Ankeny (Vic Moreno)
- ★ 10 new SigSauer P320 Nitrons
- ★ American Eagle 9mm Luger 124 grain FMJ
- ★ Bullets and cartridges collected:

  shots 1-10, then first 3 out of every 50,

  i.e. 51, 52, 53, 101, 102, 103, …

  up to 2,000 shots

CSAFE Persistence

- Bullets captured in bullet catcher collection chamber filled with Kevlar fibers (53" x 20" x 12")
- Cartridge cases in net

CSAFE Persistence

- ★ Bullets captured in bullet catcher collection chamber filled with Kevlar fibers (53" x 20" x 12")
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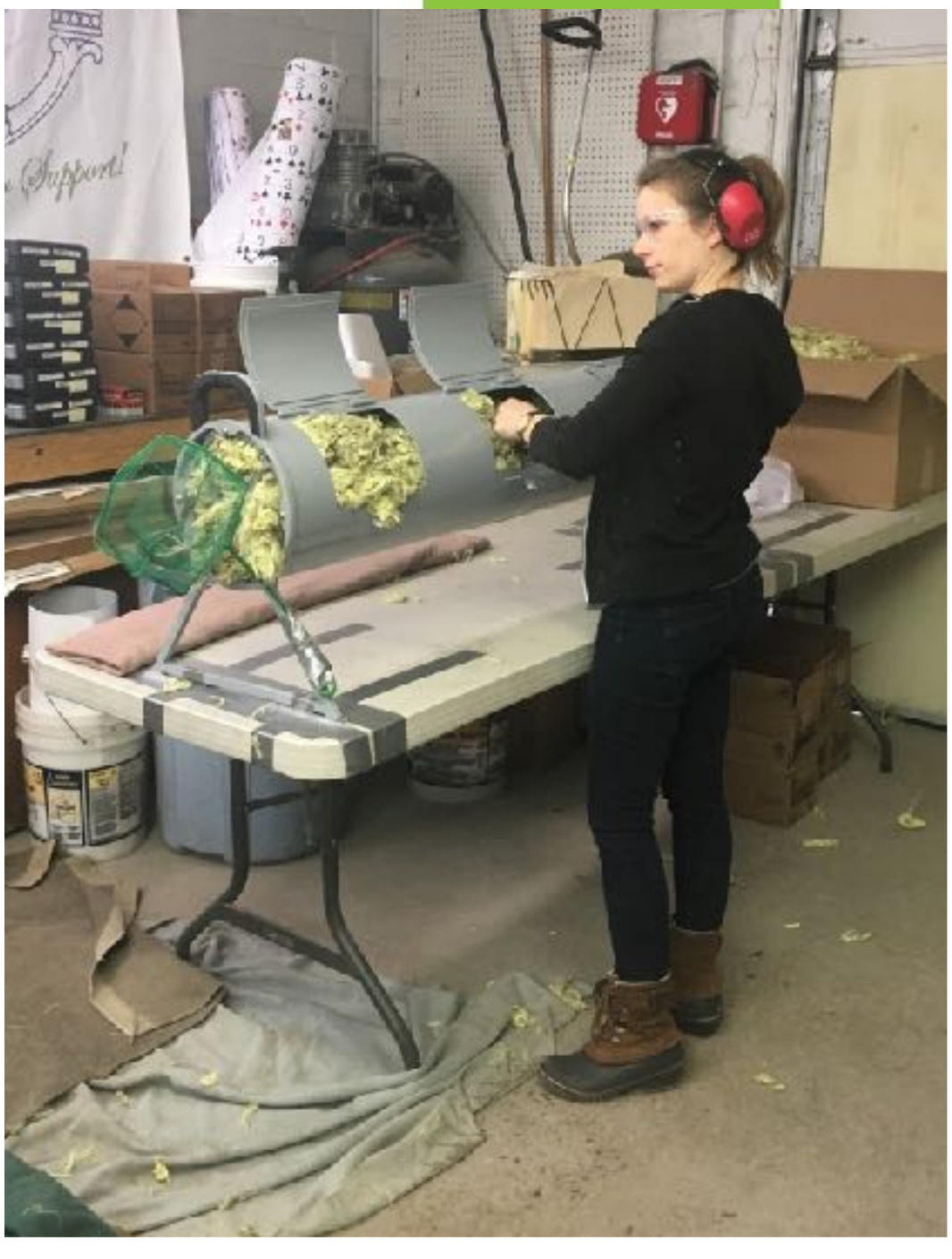
Bullet & cartridge case retrieval

- ★ lots and lots of little labelled bags
- ★ in the process of scanning



Bullet & cartridge case retrieval

- ★ lots and lots of little labelled bags
- ★ in the process of scanning

Conclusion / Question of Persistence

★ barrel persistence (under normal use) is fundamental assumption for determining same-source

★ need to assess variability within and between barrels from model/make, ammunition, …

★ NIST ballistics research database framework for keeping track of studies

★ Do you have bullets/cartridge cases from a persistence study in need of scanning? Contact us!

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Thank You!

Questions?

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ISU CSAFE bullet team

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